Status Report

Theoretical Investigation of Radiation Damage and Transport Properties of Solar Cells

1 August 1966 to 31 January 1967

Tomoyasu Tanaka
Principal Investigator

Department of Physics
The Catholic University of America
Washington, D. C. 20017

Research Grant No. NsG-649

Status Report

Introduction

Theoretical investigation of the radiation damaged solar cells and general transport properties of semiconductors has been continued. One approach is to study the effects of damages caused by radiation on the various thermal properties of semiconductors for various concentration ranges and for various species of damages. The other is to study how the radiation damages are annealed with elapse of time as the temperature of the sample is increased.

Current Research and Results Obtained

1. A paper entitled "Simple Power Law for the Introduction Rate of Defects in Semiconductors under Steady Irradiation" written by M. M. Sokoloski and T. Tanaka was presented at the International Symposium on Lattice Defects in Semiconductors, September (1966) Tokyo. Details of this paper has been written as a NASA internal progress report by Sokoloski. This paper also discusses a method of solving a set of non-linear differential equations for given initial conditions and for time intervals which range over 6 decades. Solution of non-linear equations over such a long time interval is not obtained by the usual power series method because of convergence difficulty. The method discussed in this paper is applicable even to such time intervals as big as 6 decades. The paper will be submitted for publication in the Physical Review shortly.

2. A paper entitled "Green's Function Theory of Nonlinear Transport Coefficients" written by T. Tanaka, K. Moorjani and T. Morita has been published in the Physical Review, Vol. 155, pp 388-392 (1967). The formulation is quite general and it has a wide applicability. The mechanism of ultrasonic amplification in semiconductors and microwave harmonic generation in magnetic insulators can be analysed from the point of view of the present formulation.

3. J. B. Jalikee (full time graduate assistant) has completed his Ph. D. theses on the "Theory of Impurity Conduction in Semiconductors". In this theory it is attempted to find the temperature dependence of the electric conductivity of impurity semiconductors over a wide range of impurity concentration. A general result is obtained which includes formulations of previous authors as special cases.

Future Program

Investigation of the Effects of Vacancy and Impurity upon various Properties of Semiconductors. Thermal, electrical and optical properties of semiconductors depend strongly upon the vacancies and impurities present in semiconductors. Recently the identification of specific impurities as the origin of specific anomaly in the physical properties became more important and a detailed study of the properties of a specific impurity has become the subject of interest.

Recently the method of calculating from first principles the vibrational frequencies of crystals which have various defects has been formulated.

This method is based on the fact that the cohesive energy of the crystal, metallic or semiconductive, can be calculated from the atomic core potentials by the method of pseudo-potential. Therefore, even the lattice energy of a distorted crystal can be calculated by the same method. It is,then, possible to eliminate the conventional mass-spring model completely. In this way there is a hope to be able to obtain reliable values for the frequencies of localized mode associated with a particular impurity or vacancy in semiconductors or the electronic states of the same defect. Our future effort will be concentrated on the calculation of properties, such as the energy of formation of a defect, the energy of activation, electronic states and hopefully the annealing and transport properties of semiconductors which have various defects.

Personnel

Tomoyasu Tanaka	Principal Investigator. Full time during summer months. Visit NASA Goddard Space Flight Center regularly and participate in seminars and discussions. During sabbatical leave (Sept. 1, 1966- Jan. 31,1967) stayed at the Institute for Solid State Physics, University of Tokyo, Japan. Attended International Symposium on Lattice Defects in Semiconductors and many other Physical Society meetings and symposia held in Japan. Engaged in full time research on the grant during the period.
Kishin Moorjani	Post Doctoral Fellow. Full time until Sept. 1966. Worked on the optical properties and nonlinear effects in semiconductors. Left for Europe in October 1966.
J. B. Jalikee	Full time graduate student until July 1966. Full time Post Doctoral Fellow until Sept. 1966, then left for Europe. Worked on the theory of impurity conduction.
E. L. Madsen	Full time graduate student working on nonlinear effects.
M. M. Sokoloski	Formerly NASA GSFC employee, now full time graduate student. He holds NASA Traineeship. Working on the theory of localized states in semiconductors.